A Discussion of Oxygen Recovery Definitions and Key Performance Parameters for Closed-Loop Atmosphere Revitalization Life Support Technology Development

Over the last 55 years, NASA has evolved life support for crewed space exploration vehicles from simple resupply during Project Mercury to the complex and highly integrated system of systems aboard the International Space Station. As NASA targets exploration destinations farther from low Earth orbit and mission durations of 500 to 1000 days, life support systems must evolve to meet new requirements. In addition to having more robust, reliable, and maintainable hardware, limiting resupply becomes critical for managing mission logistics and cost. Supplying a crew with the basics of food, water, and oxygen become more challenging as the destination ventures further from Earth. Aboard ISS the Atmosphere Revitalization Subsystem (ARS) supplies the crew's oxygen demand by electrolyzing water. This approach makes water a primary logistics commodity that must be managed carefully. Chemical reduction of metabolic carbon dioxide (CO_2) provides a method of recycling oxygen thereby reducing the net ARS water demand and therefore minimizing logistics needs. Multiple methods have been proposed to achieve this recovery and have been reported in the literature. However, depending on the architecture and the technology approach, "oxygen recovery" can be defined in various ways. This discontinuity makes it difficult to compare technologies directly. In an effort to clarify community discussions of Oxygen Recovery, we propose specific definitions and describe the methodology used to arrive at those definitions. Additionally, we discuss key performance parameters for Oxygen Recovery technology development including challenges with comparisons to state-of-the-art.